COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

JUL 23 1943

July, 1943

Welding inside boiler drum

Interpretation of Analyses and Problems Encountered in Water Deposits ▶

Fuel Problems in Brazil and Argentina ▶

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A-742 A

COMBUSTION ENGINEERING

200 MADISON AVENUE, NEW YORK, N. Y.

COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

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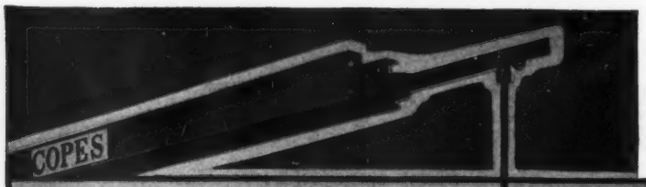

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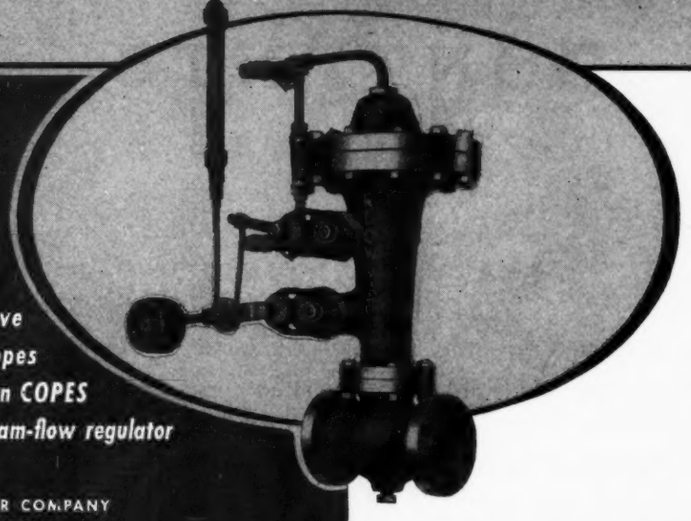

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EDITORIAL

A New Secret Weapon?

Under a headline "Revolutionary Propelling System of Fleet Revealed as New Secret Weapon," one of the New York dailies recently characterized the employment of moderately high steam pressures and temperatures as a means of permitting our warships to go further and *hit harder* than those of any other nation, and proceeded to expound the revolutionary features of 400 pounds pressure and 700 F steam temperature.

Presumably, the basis of this story was a perfectly sane release by the Navy Department tracing the evolution in naval practice from former low steam pressures to 400 pounds and 700 F in the earlier destroyers, to 600 pounds and 850 F in the later destroyers and capital ships, and mentioning also one rebuilt destroyer that is operating with 1300 pounds and 925 F. It was pointed out that these higher pressures and temperatures had resulted in increased efficiency and speed and thus afforded greater area of action, all of which had gone hand-in-hand with the rapid improvement in gunnery and armor.

Just why the reporter singled out the 400 pounds pressure and 700 F as a "secret weapon" or how he figured it would enable our ships to hit harder, must be left to the imagination, of which he undoubtedly had his share. While engineers who read the story were probably amused, the reactions of the laymen are likely to have led to false conclusions.

Such incidents raise the question of how much credence should be attached to newspaper articles dealing with technical subjects.

Overfire Air

While the advantages of overfire air have long been appreciated and its employment with stoker firing has been widespread, the many conversions of late from oil to coal have served to emphasize its importance and stress the dearth of published design and performance data.

It would appear that too often overfire air is regarded merely as a means for supplying additional air for combustion and that its most important function, namely, the creation of sufficient turbulence for complete combustion, is overlooked. To satisfy this dual purpose not only must enough air be thus supplied, usually from ten to fifteen per cent of the total, but it must have sufficient velocity, and the jets be so located as to penetrate the gas envelope. In this way stratification is broken up, combustion is speeded, the flame travel is reduced and smoke is eliminated.

A separate fan for supplying this air permits stepping up the pressure above that in the stoker windbox and provides flexibility in control. This practice is followed in most of the larger units. For small units and in many conversion jobs, owing to the present difficulty in procuring such fans, steam jets are being employed to break up stratification and induce the necessary air. Moreover, in some cases where conversion has become necessary, the furnace volume, proportioned for oil, is found to be inadequate for coal without the assistance of overfire air to break up the products of combustion and assure complete burning without the production of smoke.

This led to the initiation of a program of research at Battelle Memorial Institute, Columbus, O., aimed at finding the optimum form and size of steam jet nozzle for various conditions. A review of the results to date was contained in a paper by R. B. Engdahl before the Smoke Prevention Association Meeting in Pittsburgh last month. It is suggested that any one confronted with the necessity of installing steam jets might well inquire into these findings before proceeding.

Censorship

On July first the Board of Economic Warfare discontinued its practice of passing upon and granting a license to technical publications having circulation outside the United States. Its reason, as stated, was that the editors of such publications had done such a satisfactory job of voluntary censorship that this additional precaution proved unnecessary. In fact, it was soon recognized that the censors of BEW could not possibly be familiar with all practices in the various fields, both here and abroad, and that the editors were usually in a better position to pass judgment. While in the beginning there were occasions when material was questioned, through a desire to play safe, the BEW censors were usually open to conviction, and as a result relations with the publications were generally very cordial.

Of course, the Code of Wartime Practices, as issued by the U. S. Office of Censorship, is still operative and applies to every type of publication, including advertising matter. It is compiled as a guide for editors in censoring their own operations and is specific as to what constitutes information that might be of aid to the enemy. As applied to the power plant field, a perusal of its contents reveals only a prohibition against the publication of aerial photographs and maps, and any reference to sabotage or damage resulting from enemy attack. Moreover, the Code does not attempt to cover information concerning war establishments that has been passed upon by the proper military authorities.

Occasionally, managements tend to lean over backward in releasing information concerning their installations for fear of violating some rules of censorship. It might be well in such cases for them to procure copies of the Code from the Office of Censorship, Apex Building, Washington, D. C.

Fuel Problems in Brazil and Argentina

By J. B. CRANE

Combustion Engineering Company, Inc.

Some first-hand observations on the present fuel situation in Brazil and Argentina. With imports of coal and oil practically cut off by the war, resource has turned to the burning of wood, grain and other vegetable products in Argentina and gas generated from charcoal has largely displaced gasoline in Brazil.

ALTHOUGH we in the United States are experiencing rationing of gasoline and fuel oil and later may have to have our coal rationed, it is different in South America where they have always had to import fuel and now are unable to get any because of war conditions. The writer left Miami April 2 and spent about two months in Brazil, visiting the states of Rio de Janeiro, São Paulo, Paraná and Rio Grande do Sul; then spent a week in Buenos Aires and returned to Miami on June 17 via Bolivia and the West Coast of South America. He was principally interested in power plants and fuel-burning equipment and believes some COMBUSTION readers may be interested in some of the things observed.

Brazil

This country has a large amount of hydro-electric power but the principal developments near the centers of population are now fully employed. Use of the large undeveloped water powers will require the construction of expensive plants and high-voltage transmission lines to bring the electricity to existing industrial centers or chemical plants and other large users of electric power must locate near the sites of such power. One such important site is along the San Francisco river. However, despite the availability of water power, dependence upon it is somewhat lessened by periods of low water due to low rainfall or unequal distribution of rainfall in some years, and the fact that many modern manufacturing processes require large quantities of heat or steam makes fuel an ever growing necessity. In 1938 Brazil mined 883,000 tons (2200 lb) of coal and imported 1,576,000 tons or used a total of 2,459,000 tons,[1] as none was exported, whereas in 1942 Brazilian mines produced 1,100,000 tons, according to figures published while the writer was there. In the latter year a minimum amount was imported because of a scarcity of boats for such service. Brazil produces no oil but it is expected that some day the Amazon basin will show large quantities of oil.

Gasoline is prohibited for use of private cars, hence the "gas-o-genio" has taken its place for all private cars as well as for many buses and trucks.[2] This uses gas generated from charcoal. For the private cars two tanks about 20 in. in diameter and 4 ft high are placed on a hinged rack at the rear of the car. This can be swung to one side in order to get at the trunk. One tank is filled with two bags of charcoal, which is lighted and the engine pulls the gas through the charcoal, and a cleaner or filter in the other tank, and so to the engine. No changes are made in the carburetor. In some cases the choke is left wide open, but it tends to become coated and must be cleaned before it can be closed in order to change to gasoline. Therefore, in many cases a special mixing valve is provided. The suction of the engine does not draw enough gas to get full power but the car operates very nicely at half speed. On trucks and buses the tanks are at the front and a small fan is provided ahead of the engine to draw more gas and get full power. Information supplied the writer indicated that 2 kilometers per kilogram of charcoal (0.546 miles per lb) and 80 to 90 kilometers on one charge of two bags (48 to 54 miles) could be expected.

All gasoline stations carry charcoal and usually two or more bags are carried in the car trunks. One man reported having made a two-day cross-country trip through hilly sections covering 300 miles, with no trouble except that it took longer than with gasoline. In fact, it has been found more economical than gasoline. All gasoline for certain rationed vehicles must have 20 per cent alcohol mixed with it. This alcohol is produced from sugar and thus far the mixture has been found to work satisfactorily.

The industrial plants and many of the railroads are using wood, coffee husks, nut shells, cotton-seed cake and husks, or anything else they can find for fuel.

A new seam of coal has been located in the State of Paraná. This is suitable for coke and is expected to take care of a new steel plant which will require approximately 1,000,000 tons per year. The State of Rio Grande do Sul has opened a new coal mine at Bagé, and is now using this coal on the state-owned railroad. In Paraná a new paper mill is being erected to make pulp and newsprint paper. They have already planted 1,000,000 eucalyptus trees for fuel. In four years such trees are ready to cut for fuel and they are used for this purpose in many sections of Brazil. A large number of pine seedlings have also been planted for this purpose.

The writer made his first trip to Brazil in 1916 and again in 1939. He was very much impressed with the way they are taking care of their own needs in these trying times and believes Brazil will grow much more rapidly after this war than ever before.

Argentina

In 1938 according to the Pan-American Union, Argentina imported 3,116,635 tons (2200 lb) of coal and mined 5,000 tons. Some 2,380,000 tons of oil were also produced. However, no coal is now being imported. The coal output has increased slightly but the source of this

[1] According to the Pan-American Union.
[2] According to the U. S. Department of Commerce 2000 automobiles in Rio de Janeiro and about 10,000 in São Paulo are so equipped.

coal is in the Andes and thus far no large-scale operations are contemplated. The oil was and still is being used in Diesel engines and by the railroads. Theoretically gasoline is rationed, but ration tickets are readily obtainable by anyone with the necessary money which is 10 per cent of the price of the gasoline.

The power plants and industries which imported coal or oil are having a tough time. Argentina normally raises 4,000,000 tons (2200 lb) of corn per year. In 1940 shipments to Europe were discontinued until there was over 8,000,000 tons on hand. The price rapidly fell until it reached $9.00 per ton and at this point the Argentine Government froze the price and then gave orders to use it for fuel, making up to the farmer the difference between that price and its fuel value price of $4.00 to $5.00 per ton. Corn burns readily but has a heating value of only 7000 Btu per lb, or about half that of the coal which was formerly burned. On small boilers ovens were placed in front of the furnaces with additional grate surface and sufficient corn on the cob could be burned in this manner to keep the plant going.

Methods of Burning Corn and Seeds

Where underfeed stokers were installed, shelled corn was burned and by speeding up the stokers output was maintained. For large power units, flour mills ground the corn into flour and it was blown directly into the furnace. However, larger burners and large piping had to be provided. In fact, one large public utility plant in Buenos Aires burned several million tons of corn in this manner. By now practically all the corn, has been burned and a drought has reduced this seasons crop to 1,900,000 tons so that linseed is being used for fuel. Linseed cannot be burned on grates or stokers because it flows like oil, but it can be blown directly into the furnace. As the seed is heated, the oil inside causes the seed to burst. The utility plant mentioned is putting the linseed through the flour mills so they can readily go back to corn when this becomes available. Linseed oil mills are now required by law to leave 12 to 14 per cent oil in the cake which is double the usual amount. This makes the cake suitable for fuel instead of employing it for stock food.

In Argentina one sees acre after acre of sunflowers. The seed is crushed and the oil used for making a brand of olive oil or other edible oils. The husk make a fine fuel and one plant gets enough fuel in this way to run for twelve days per month. Middlings or bran do not make a good fuel. At 60 per cent of the capacity obtained with other fuels the ash seems to combine with the refractory and cause it to run. There is no trouble if the furnace is lined with water walls.

Charcoal, where available, is ground and burned with the coal.

Wood is used wherever possible. Quebracho, two pounds of which has a heating value equivalent to one pound of coal, is available in the Chaco section, and where transportation facilities are available, a large amount is burned. Buenos Aires has a climate much like Virginia except that there is no record of snow in Buenos Aires. Oranges and lemons grow in Buenos Aires but not the papaya. Most of the private houses are heated by fireplaces. Quebracho this year is taking the place of channel coal. It is buried in the ashes at night and retains enough heat to start the fire the next morning.

From the foregoing it will be seen that the fuel supply of South America has been badly dislocated by the war. Similar difficulties were experienced during World War I, but the fuel demands were then much less than now. These demands are bound to increase still more with the growing industrial development of these countries.

Facts and Figures

Approximately two-thirds of the power used in the paper industry is privately generated.

•

The war industrial facilities financed by the Government to date aggregate over fifteen billion dollars.

•

More than a third of the total number of persons now employed are 45 yr old or older, according to the War Manpower Commission.

•

Job accidents since Pearl Harbor are claimed to have killed more production workers than have the Nazis and Japanese our fighting men.

•

Most of the free-burning coals, when burned on chain- or traveling-grate stokers give the best results if the maximum sizing is about $^3/_4$ in.

•

According to the Office of War Information, for the past four years oil production has been less than consumption; hence the present depleted stocks.

•

A large office building is reported to have effected a 20 per cent reduction in the steam used for heating hot water by reducing the temperature from 140 F to 120 F, the latter proving entirely satisfactory.

•

"For the first time in history," says Secretary Ickes, "a single power plant has operated at more than a million kilowatts output." He refers to the Boulder Dam installation on the Colorado River which is operated by the Bureau of Reclamation.

•

A patent was taken out in England in 1869 applying water cooling to an oscillating grate. Another was taken out in this country in 1895 covering the application of water cooling to a chain grate and around 1909 several water-cooled stokers of the overfeed type were installed in this country.

Correction—An error inadvertently was made in the wording of an item in the "Facts and Figures" column of the June issue and was not detected before the magazine went to press. The item should have read: "It is not the amount of wall surface installed that determines the heat *absorption*, but rather the surface of the flame envelope."

Interpretation of Analyses and Problems Encountered in WATER DEPOSITS

In these excerpts from a paper by J. A. Holmes† and A. O. Walker† presented at the Annual Meeting of the A.S.T.M., Pittsburgh, June 28 to July 2, 1943, the authors consider some of the problems encountered when investigating samples of scale and review the methods employed to identify the components of the scale. These methods include chemical analysis, microscopic examination, petrographic examination and X-ray diffraction. The applications and the limitations and advantages of each are discussed.

IN GENERAL, there are four different methods of investigating a deposit.

1. Chemical analysis
2. Ordinary microscopic examination
3. Petrographic examination
4. X-ray diffraction examination

Chemical Analysis

The chemical analysis method is the one most employed, and is still necessary even if other methods are used, because it gives clues for materials to be looked for by the microscopist and is an added check on results. For ordinary scales such as carbonates, sulphates, iron or those relatively simple in structure, the chemical analysis is usually sufficient in itself.

One of the disadvantages of chemical analysis is that there are sometimes several different combinations that can be made, and it does not show which one is correct. This method gives exact percentages of various elements present whereas other methods only approximate percentages and often miss the presence of materials present in minute quantities.

In the chemical analysis method, the most common source of error by inexperienced analysts has been in the determination of alumina. In a scale containing iron and phosphate, the determination of alumina is a procedure open to serious errors, unless certain precautions are taken. The alumina is usually determined by difference in the R_2O_3 group. The percentage of P_2O_5 and Fe_2O_3, which are determined independently before the R_2O_3 is precipitated, is subtracted from the total R_2O_3 precipitate. The difference is alumina. In order to prevent occlusion of CaO in this precipitation, it is necessary to add sufficient standard iron solution to have an excess of Fe, otherwise CaO will be precipitated as calcium phosphate and weighed as alumina. To assure complete removal of CaO, it is necessary to carry out a double precipitation of the R_2O_3 group.

Another source of error is the incomplete dehydration of the silica. If the dehydration is not complete, some silica will remain in a colloidal form in the solution of iron, phosphate and alumina, and will come down with the R_2O_3 group to be weighed as alumina.

Microscopic Examination

The ordinary microscopic method is used mainly in looking for contamination of the deposits during sampling and handling. Pieces of metal from turbines or from too severe scraping, lint, splinters and other materials may throw off other methods of analysis. This method is very helpful in observing the various laminations or layers of deposits and in segregating these layers. The density or compactness of the deposit is also observed by this method.

Not all of the constituents of water deposits are mineral in nature, some being composed of bacteria, fungi or algae. Many analysts have been confused by the presence of these organisms in deposits (mostly of a soft, slimy nature). Since these organisms are composed of at least 90 per cent water, chemical analysis will show a high moisture loss, or, if the samples are allowed to dry out in shipment, these organisms may not show up at all in the chemical analysis. Even though the samples show a loss on ignition, there is no way to differentiate between organic material due to organisms or that due to natural vegetation or other sources. Microscopic examination is the only way to analyze these deposits and all iron scales or any products of corrosion should always be thus investigated.

Microscopic examination is also used to test unknowns by watching color changes or crystal formations after adding reagents to the surface of a deposit.

Petrographic Examination

The third or petrographic method makes use of the polarizing microscope which measures optical properties of the crystals. This is limited to those compounds that form definite crystals above a certain size. It has enabled the analyst to identify many compounds in scale, and is valuable for rapidly obtaining the approximate composition, especially when the source and the conditions under which the scale was formed are known. This saves long and tedious chemical analysis.

† Director of Service, and Chief Chemist, respectively, National Aluminate Corp., Chicago, Ill.

Disadvantages of this method are that there are still compounds of crystalline structure too small to be identified, and it does not identify amorphous materials. Considerable experience and a fairly expensive microscope are also necessary.

X-ray Diffraction Examination

The fourth, or X-ray diffraction method has a much wider range than the petrographic method and will identify compounds of any crystalline structure if the X-ray pattern is known. At the present time, it is the last resort to identify the compounds present, but it does not identify an amorphous deposit. However it requires a highly trained technician and expensive equipment.

Without this method, it is impossible to identify positively some components of scale. For example, systems of probable combinations may suggest combining the CaO and P_2O_5 as calcium triphosphate, whereas the X-ray shows these components definitely present as calcium hydroxyapatite or $Ca_{10}(PO_4)_6(OH)_2$. Some chemists have reported calcium phosphate and free lime in scales when they should have reported the hydroxyapatite.

Identification of Compounds

The calcium carbonate and calcium sulphate scales are easily identified by the petrographic method and, in some cases, by the ordinary microscope. The unusually high birefringence of calcium carbonate makes it easily identified by examination between crossed-nicol prisms. The amount of calcium carbonate can be estimated with a fair degree of accuracy. Calcium sulphate scales are usually easily identified by the appearance of the crystals which are relatively large and consequently the optical properties can be readily determined.

The presence of other constituents in scales is not so readily apparent. The silicates do not always form crystals large enough for microscopic study, but a few silicates have been identified by their optical properties. The presence of the mineral xonotlite ($5CaSiO_3 \cdot H_2O$) has been identified by Clark and Bunn[2] using the X-ray diffraction method. By means of its optical properties, it has been found in some scales encountered in our laboratory. Partridge has reported the mineral radiophyllite $CaSiO_3 \cdot H_2O$. A sodium-calcium silicate, pectolite, has also been identified by Clark and Bunn.[1]

Of the sodium aluminum silicate encountered in scales, the mineral analcite has been positively identified in only a few scales by optical properties. One of these was from the blades of a low-pressure turbine and the other was from the dry spot on a tube from one of our experimental boilers, so conditions must evidently be such as to allow for crystal growth. Scales are encountered which by chemical analysis contain the elements of analcite or zeolite scales in approximately the correct proportions but there were usually no visible crystals. The X-ray method is needed to show the presence of these complex compounds.

Calcium phosphate does not form crystals large enough for microscopic study, although one may become familiar with their general appearance under ordinary microscopic examination. The X-ray method has confirmed that calcium phosphate is usually present as hydroxyapatite, $Ca_{10}(PO_4)_6(OH)_2$.

Scales containing predominantly magnesia will calculate to various magnesium silicates, magnesium oxide and magnesium hydroxide. The magnesium hydroxide can be identified under the microscope. If magnesium oxide were present in sufficiently large particles, it would be immediately apparent due to its unusually high index of refraction. The magnesia is probably tied up with silica in a complex silicate of indeterminate optical properties, due either to widely variable composition, submicroscopic or non-crystalline character.

The presence of iron compounds can usually be inferred by the color of the particles. The iron often stains the crystalline substances present. The presence of crystalline iron silicates has been known, but the optical data were not determined due to the fact that the index of refraction of the crystals was above the range of the usual index liquids. However, the fact that the index was so high indicates that an iron silicate was present since the oxides of iron have not been encountered in crystalline form satisfactory for optical identification.

The presence of free metal in a scale can usually be confirmed by microscopic means. The particles, if they are large, will exhibit a metallic luster. A test with silver nitrate will also reveal the presence of copper or other heavy metals. The formation of sparkling crystals of silver immediately confirms the presence of free metal in the scale.

Considerable information can be obtained about the conditions under which scale is formed by examination with the ordinary microscope. One can distinguish between baked-on sludge and true crystal deposition. It is also useful in studying the alteration in scale structure due to different treatments, water changes, concentrations of boiler water solids or even changes in operating conditions.

A medium power binocular microscope is the most useful, due to the fact that it furnishes stereoscopic vision and is much easier on the eyes when used for prolonged periods.

Conclusion

The question usually brought up is whether there is any great value in determining the true identity of compounds in scale or is the mere determination of the various radicals or elements present sufficient. In other words, if there is calcium, magnesium, silica, iron, or alumina present, what matters other than their elimination from the feedwater? If there are corrosion products, then eliminate the corrosion by properly treating the water.

In general this may be true, but this is not sufficient for the cases where the cause of the deposit is not easily determined because all treating and operating conditions appear to be perfect. Furthermore, these various elements are present as definite compounds, and, such being the case, it is the job of a good analyst to identify and report their exact composition and as far as possible their physical characteristics. If this is done, then there is a much better opportunity to determine not only the source of the various components but conditions under which they are formed.

[1] L. M. Clark and C. W. Bunn, "The Scaling of Boilers—Part IV, Identification of Phases in Calcium Silicate Scales," *J. Soc. Chem. Industry (London)*, Vol. 59, August, 1940, pp. 155–158.

How to get the most out of your

CROSBY RELIEF VALVES

No. 3 Reconditioning Seating Surfaces

After a relief valve has been in service for some time, it may be necessary to refinish the seating surfaces. Severe damage must be remedied by machining, but in the usual case lapping will suffice.

Necessary Equipment: Lapping Blocks, one for each orifice size valve; Lapping Compound of various grades — see table; a Surface Plate for truing up the blocks.

In all operations as well as in the care of the equipment, cleanliness is essential. Foreign particles on the surface plate may scratch the lapping block, and if on the block, they will scratch the valve seat. Likewise a few particles of #200 compound mixed in with the finer grades will cause scratching.

For lapping the valve seat use the following guide:

1. Select the size of lapping block proper for the valve orifice letter.
2. Check the block on a surface plate to make sure it is perfectly true.

LAPPING BLOCK

3. Apply compound to the block and rotate with an oscillating motion — do not carry through a complete revolution. Let the weight of the block do the work as any applied pressure may be unequally distributed. If the seat is considerably pitted or scratched, use #200 compound, otherwise #500 will do.
4. When most of the damage marks have been lapped out, remove all compound from the seat and from the block, and clean both thoroughly with kerosene. This is important.
5. Repeat this procedure using progressively finer compound, until all marks are gone and the seat has become polished.
6. Never grind the disc against the nozzle. To avoid galling and grooving seats, lap each piece separately, using block as above.

It is a good idea to use different lapping blocks (or opposite sides of the same block) for different grades of compound.

For further information we invite you to write to your local Crosby office for "Instruction for Installation Maintenance and Adjustment of Relief Valves."

RECOMMENDED VALVE SEAT LAPPING COMPOUND

COARSE — No. 200 Mesh Carborundum — or equivalent — for rough grinding of badly scored seats.

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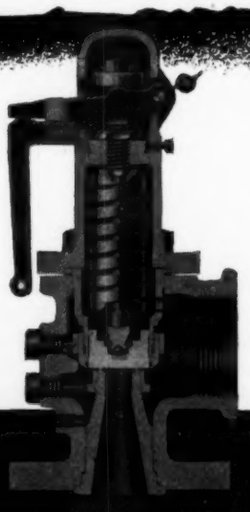

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Electric Utilities Meet War Demands Despite Added Burdens

Following are excerpts from the Annual Report of C. W. Kellogg, President of the Edison Electric Institute, as reproduced in the July *Bulletin* of that organization. It reviews the part that electric utilities have played in the war effort, shows that there is an ample margin of capacity, and discusses the man-power situation, tax burdens, energy output, financing and post-war planning.

SINCE June 1940 the combined electric generating capacity of plants serving the public supply, including private and governmental plants, has grown by 6,500,000 kw to about 47,500,000 kw at the present time. Estimated generating capacity at the end of this calendar year will be a full 50,000,000 kw. Since June 1940 the combined non-coincident peak load on electric generating systems has grown about 7,400,000 kw, so that the margin between such peak loads and the generating capacity to carry it has decreased but slightly and still remains about 10,000,000 kw.

The utilities, striving to keep ahead of estimated power requirements for new munitions plants, went even further with plans for increased generating capacity than developments later showed to be needed; and last August the War Production Board canceled or postponed completion of 2,200,000 kw of generating capacity that the private utilities were then in process of constructing. The Board found that the power supply appeared ample and that critical materials thus saved were needed more for other war purposes. The Director of the Office of War Utilities stated within the month that the power supply now available should be ample through both 1943 and 1944.

Judging by cancelations and reductions in the projected war production program that have been announced and by various other statements of officials of the Government, the end of 1944 should find the demand for power for war production decreasing. On the other hand, we may assume that, as the most effective way of combating inflation, the production of civilian goods, particularly those most essential and desirable to present-day living conditions, will have been resumed or increased before the end of 1944. This will reverse the trend of demand for power for civilian supply, which has been decreasing since 1940, so that the civilian power demand will be on the increase again.

Relation of Industrial Production to Power Demands

The Federal Reserve Index of industrial production has grown 70 per cent from June 1940 to May of this year. Two-thirds of this present total industrial activity is devoted to war. The one-third balance for civilian purposes corresponds with the level prevailing during the depression period of the 30's. In the past three years the peak demand for electricity has grown only 25 per cent. The reason for this marked difference has been the big improvement in load factor (58.6 per cent at the present time), and this in turn is due in part to longer hours of plant operation and in part to the establishment of Standard War Time.

Energy Output

In energy output, the total for all agencies contributing to the public supply passed the 200 billion kilowatt-hour mark in the twelve months ending May 1943, an output more than double that for the boom year 1929. It represents a gain over the previous twelve months of 13.6 per cent. In 1942 Federal Government plants produced about 10 per cent of the total electric energy.

If the output of isolated industrial plants is included, the total supply of the country, from all sources, is now in excess of 250 billion kilowatt-hours a year.

It is indicative of the stability of electric utility service that in spite of the enormous power demands of the war industries the proportion of industrial power sales to total sales for all classes of service was actually less than during the period from 1926 to 1929. In 1942 industrial power sales represented 55½ per cent of the total. In 1929 they represented 57 per cent of the total.

Customers

The effect of the war on the number of customers is noteworthy. Residential customers continued to gain in number up to last November, primarily on account of defense housing. Since that time the number has been decreasing slowly. Retail commercial customers have been decreasing substantially for more than a year.

Revenues

Gross revenues of the electric utilities totaled $2,665,000,000 for the twelve months ending May 31, 1943, representing an increase over the previous twelve months of $140,000,000, or 5 per cent. This entire growth was mostly offset by increases in Federal taxes; operating expenses, in spite of increased wages and increased costs

of supplies, having been held to a very small increase by careful planning and the exercise of rigid economy by management with respect to those elements of operating expense subject to its control. Thus the net income of stockholders in the period referred to was about the same as it was for the twelve months ending one year ago.

Financing

Last year about $480,000,000 was expended by the utility companies for new construction. Of this only one-sixth had to be raised by the sale of securities, the balance coming from current funds. The present estimated construction budget for 1943 (of $270,000,000) can be financed completely from current reserves.

Man-Power

As of May 1943 the electric utility industry, which in 1940 had 275,000 employees, had contributed about 40,000 of its employees to the armed forces. It is estimated that about 60,000 to 75,000 additional men had been drained away from utility companies to other war industries. These losses have been offset in part by the employment of about 10,000 women to replace men and the employment of about 30,000 men replacements, mostly older men or those not meeting the physical requirements of the armed forces. Total employment in the electric utility industry, which reached a peak of 288,000 in August 1941 when construction was at a maximum, had fallen to approximately 220,000 by June 1 of this year, which represented a net reduction of 68,000 employees, or 24 per cent.

Fuel Storage

At the request of the Solid Fuels Administration, the electric utilities at considerable expense enlarged their coal-storage capacity so that last fall they carried on hand 110 days' supply of coal and came through the winter with a net reserve of 100 days' supply, the best showing in this respect of any industry in the country. This was a nationwide average; the figures were lower in fuel-producing areas.

Taxes

Taxes upon the electric utilities now take 25 cents out of every dollar of gross revenue. Federal taxes constitute the lion's share of this. Unlike governmental utility enterprises in Great Britain, which pay both local taxes and national government taxes, government power systems in this country pay no Federal taxes, practically no local taxes and in general make contributions in lieu of local taxes substantially less than such taxes imposed upon electric utilities. Generally speaking, Federal hydro electric projects pay no interest on capital. In the case of privately owned utilities, taxes plus return on the investors' capital represent half of the total cost of furnishing power, and for hydro plants the ratio is much higher. These facts are well known and they represent enormous subsidies which the Federal taxpayer is called upon to make to advance government ownership. Nevertheless, many government officials continue to broadcast claims as to the cheapness of power from projects under government ownership compared with the cost of power from projects under business management.

Other Burdens

The preparation of reports, the answering of questionnaires, and supplying of information to many government agencies constitute a heavy burden upon business management. For the electric utilities this amounts to many millions of man-hours or work that could otherwise be diverted into other channels of production. It is recognized that much of the information called for is necessary to the making of important decisions in Washington, but more care and frugality in making demands could surely result in a substantial reduction in the amount of this work.

Since Pearl Harbor about 6 million man-hours of work and a large part of the time of many utilities executives that should have been devoted to the efficient operation of power systems have been spent in preparation for and attendance upon integration proceedings before the Securities and Exchange Commission and historical cost proceedings before the Federal Power Commission, all of which could well be attended to after the great task of winning the war is over.

Farm Electrification

The movement to get electric service to the farms of the country was started by the electric utility industry forty years ago and has been formally pursued by them under the title of "Rural Electrification" for twenty-two years. During the last eight years the Federal Government, as a social policy similar in concept to the Rural Free Delivery of the Post Office Department, has used Federal funds to foster the extension of electricity to rural areas too sparsely settled to justify the investment of private capital for their electrification.

Farm electrification has been stopped, practically speaking, by the war demands for copper and steel, but it will doubtless be one of the active fields for post-war effort.

If the people wish to use Federal funds to subsidize the cost of getting electricity to farms which otherwise could not obtain it, the electric utilities cannot reasonably interpose objection; but the modification of the REA program to include unneeded duplication of power plants and transmission systems and to compete for non-farm power business against tax-paying companies is deplored.

Post-War Planning

It is not too early to begin to appraise and prepare for the serious problems we can already discern in the pathway lying before us. This industry normally projects its thinking and planning five to ten years ahead. The justification for giving this more than the usual attention lies in the fact that we are confronted by the prospect of unusual changes—changes in competitive conditions, labor conditions, money conditions, new technical developments and perhaps further changes in the relations between Government and business. The alert and thoughtful management, with both feet on the ground, is in the best position to meet successfully the vicissitudes of a period of change and adjustment. For this reason electric utilities are much interested in the plans of other industries and organizations and has appointed a post-war planning committee to keep in touch with other industry-planning organizations.

Influence of Storage Upon Lignite Size Degradation

DESPITE the fact that more than 18 per cent of the Nation's reserve of solid fuel consists of lignite, only a very small amount is being utilized. It is a low-rank fuel averaging between 30 and 40 per cent moisture, 6 to 15 per cent ash and a heating value of 6000 to 8000 Btu per lb.

Failure to utilize lignite to a greater extent is in part attributable to rather widespread misconceptions as to the heat losses attending its use. The high proportionate moisture content and the loss resulting from its presence have not been generally understood, and failure in many cases to employ appropriate grate surface has caused lignite to be maligned with regard to sifting losses resulting from size reduction as heat is applied and the moisture is driven off. Also, serious misconceptions exist as to the tendency of lignite to undergo size reduction while in storage and during handling.

This last aspect was discussed in a paper by **Prof. C. J. Eckhardt, Jr.,** and **C. W. Yates** in a paper before the A.S.M.E. Spring Meeting at Davenport, Ia., April 26–28, 1943. In this, the authors reported the results of tests covering "size degradation" (the tendency to undergo reduction in size while in storage) and "size stability" (ability to withstand reduction in size when being handled after storage). Since accelerated laboratory-test procedures are not applicable to a low-rank fuel such as lignite, the tests were conducted for a period comparable to that normally involved in the storage of such fuel.

Tests for Size Degradation

In order to conduct suitable tests in this case, an aggregate of 22,500 lb of lignite, consisting only of particles passing through a 3-in. round-hole screen and retained upon a 2-in. round-hole screen, was placed into the following types of storage:

1. Samples exposed completely to the atmosphere.
2. Samples exposed to the atmosphere but protected from sunshine.
3. Samples exposed to the atmosphere but protected from rain.
4. Samples exposed to the atmosphere but protected from sunshine and rain.
5. Samples exposed to the atmosphere in a basement.
6. Samples sealed in metal cans and subjected to atmospheric temperature.
7. Samples submerged under water in sealed metal cans.

The amount was sufficient to permit removal of samples from storage for test purposes with regard to size degradation and other tests at the end of various periods.

These tests were begun in midwinter and completed in the summer. Thus a wide variety of weather was experienced. Temperatures as low as 17 F and as high as 100 F were encountered; and the relative humidity varied through a wide range. There were rains of small magnitude upon frequent occasions, whereas those of considerable magnitude were less frequent. Sunshine per month ranged from 50 to 77 per cent, the greatest irregularity in this respect occurring in the early part of the test period. The extent of the size degradation was as follows:

Class of Storage	Size Degradation at End of 160-Day Storage Period, Per Cent
Exposed completely to atmosphere	81.1
Exposed to atmosphere but protected from sunshine	70.0
Exposed to atmosphere but protected from rain	28.2
Exposed to atmosphere but protected from sunshine and rain	17.1
Stored in basement	9.6
Sealed in metal cans	8.8
Submerged under water	5.2
At beginning of test	3.2

Under certain classes of storage, the duration of the storage period is of significance. In other cases, it appears to be of small importance. The sample stored in a basement reached the 10 per cent degradation point in 160 days. The same point was reached by the completely exposed sample in 15 days. For all classes of storage, the extent of degradation appeared to be greater in the early storage period than in the later stages.

Tests for Size Stability

Storage conditions have a very great influence upon the size stability of this fuel, as measured by tumbler tests. The range and extent of this influence are as follows:

Type of Storage	Size-stability at End of 160-Day Storage Period, Per Cent
Exposed to atmosphere but protected from sunshine	48.8
Exposed to atmosphere but protected from rain	59.9
Exposed to atmosphere but protected from sunshine and rain	58.8
Stored in basement	69.2
Sealed in metal cans	81.0
Submerged under water	87.5
At beginning of tests	88.3

The character of the storage into which lignite is placed influences its friability as well as its size degradation and size stability. This is shown by the following:

Class of Storage	Friability at the End of 160-Day Storage Period, Per Cent
Completely exposed	64.9
Exposed to atmosphere but protected from sunshine	42.4
Exposed to atmosphere but protected from rain	36.5
Exposed to atmosphere but protected from sunshine and rain	35.5
Stored in basement	32.6
Sealed in metal cans	21.1
Submerged under water	24.7
At beginning of storage period	15.7

Conclusions

In the future, it seems reasonable to presume, lignite will be used as a direct source of potential energy for power-generating and industrial purposes, for the manufacture of gaseous fuels and for the manufacture of liquid fuels. It is, moreover, not unreasonable to suppose that, for some of these processes a knowledge of the size-degradation, size-stability and friability characteristics of this low-rank solid fuel may make possible the advantageous use of properties which as yet are regarded as undesirable.

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Quick Starting of High-Pressure Turbines*

TEMPERATURE differences between the individual parts of a turbine, through which a stream of expanding steam is flowing, require first and foremost that wall thicknesses shall as far as possible be kept equal. The unavoidable variations of sections and concentrations of metal such as occur, for instance, at flanges, must be reduced to a minimum, in order to avoid delays in warming up and in cooling down when load changes, and thereby to keep the temperature differences small.

In the case of high-pressure turbines it is advantageous to locate the nozzles in separate nozzle chests and to build these into the turbine casing proper. The material of the casing has then only to be chosen suitable for withstanding the reduced temperature and the lower pressure of the first wheel chamber. In order to obtain a simple connection of the various parts without massing the metal, the nozzle boxes of the casing may be welded to corresponding necks of the casing, and also the valve casings. The flange joints hitherto used are then done away with, and with them all their disadvantages. The dimensions of the unavoidable flanges must be fixed on the basis of a minimum use of material, the distribution of which has to be carefully considered.

For this reason it has been found desirable to allow for the resulting differences of expansion by deliberately increasing the length of the bolts as in the accompanying sketch. Increasing the bolt length and the use of bushes between the casing flange and nut enables the percentage expansion of the bolts to be reduced to a fraction of that otherwise obtained, thus ensuring that it remains definitely within the elastic limit. Permanent extension at the bolt shanks, and the consequent leakage at the flange, are thus avoided. Because a simultaneous warming-up of the bolts with the flanges tends to keep the tensile stresses low, it is important that the bolts be screwed directly into one of the flanges; simple through-bolts should not be employed.

In the case of high-temperature turbines, it has, in addition, been found advantageous to heat the flanges externally, in order to obtain a rapid equalization of the temperatures over the entire flange portion. Such a flange-warming arrangement is constituted by two welded-on tube halves through which live steam is passed. Since live steam is employed, it is always possible to obtain any desired heating temperatures by correspondingly regulating the pressure in the heating device.

The general design of the casing must in the first place be such as to ensure uniform expansion during warming-up. For example, in impulse turbines care has to be taken to make an allowance for expansion of the diaphragms inside the casing. In the case of reaction turbines having an impulse wheel in front of the reaction blading, sudden changes of section between impulse wheel casing and reaction parts must be avoided. It is also advantageous to locate the first part of the reaction blading on a separate blade-carrying ring mounted in the casing.

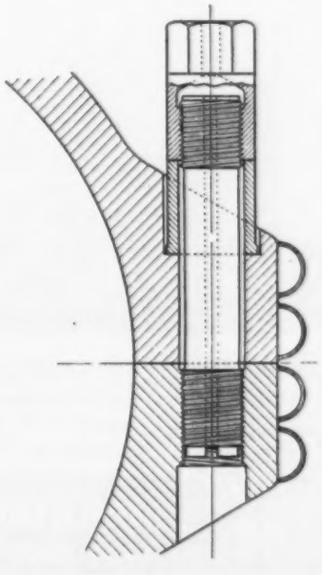
In addition to other operating characteristics of steam turbines, the possibility of quick starting is important, especially in view of the wide use of increased pressures and high temperatures. Because high steam temperatures mean increased temperature differences, careful attention to both design and operation is essential. The following notes review certain design features adopted by Brown Boveri to cope with this problem and discuss operating considerations applicable to turbines in general.

The large temperature difference of such superheated steam turbines requires also that corresponding attention be given to the design of the rotor. Wheels or drums carrying blading shrunk on the shaft warm up more quickly during starting than the shaft does, as the latter is practically not in contact with the steam; they also cool down more rapidly, especially when the load is suddenly dropped. It is no wonder, therefore, that the mechanical connection between these parts tends to become loose after a certain time, leading to a more or less severe vibration of the shaft, and causing the keys to become hammered out of shape. Some turbine designers have sought a remedy in machining the shaft and wheels out of a single forging. The advantage of doing away with hubs and of obtaining a solid metal joint with the shaft is in this case achieved at the cost of a poorer forging of the innermost metal parts, which in the course of time may result in permanent deformation of the shaft axis. These disadvantages are avoided by the so-called lip-welding process in which relatively thin resilient lip-shaped projections on both the shaft and the wheel are welded together to form a continuous circumferential joint. This weld is quite insensitive to changes of either shaft or hub diameter, as it allows a slight breathing motion between the two parts; at the same time it transmits the torque in a symmetrical manner with quite low stresses. The undesirable and uncertain key fixings are, in this way, completely done away with.

The same characteristics with regard to insensitivity to temperature are possessed by welded rotors, built up by welding together individual rotor parts at their outer periphery. The location of the welds at the periphery results in only very low stresses in the weld metal. The construction enables reliable rotors to be built, avoiding disadvantages of the design hitherto employed. As in the case of the above-mentioned lip-weld, all key fixings, and with them the danger of loose shaft parts, are done away with. This construction has all the advantages of a shaft made out of a single forging without its disadvantages, namely, high weight, poor forging of the innermost metal and local overstressing due to temperature and expansion differences. Complete freedom exists in regard to the shape given to the component parts, which can then be made so as to distribute the stress uniformly, to which is added the advantage of increased security resulting from the possibility of perfect forging and heat treatment of all parts of each component.

Operating Considerations

Although the above-mentioned design precautions make a high-temperature machine stand up well to quick starting and sudden load changes, it is advisable to consider briefly the effects of such changes, for turbines are expensive ob-



Bolting and cooling arrangements

* Excerpts from *The Brown Boveri Review*, vol. 29, No. 8.

jects, and it is certainly well worth while giving them proper attendance and care. Because temperature differences inside the casing and the rotor become increasingly great, as the time taken in putting such turbines into service is reduced, the general practice is rightly to allow a liberal amount of time for starting. If, however, because of a sudden outage of some machine, the time for putting into service of another has to be shortened as far as possible, it is important for the operating engineer to know each of his machines thoroughly and to understand perfectly its behavior during the process of putting into service.

When steam is sent into the cold turbine of a unit which is being started, it condenses on the walls of the housing and on the rotor; hence, the maximum temperature which these surfaces can attain, is the saturation temperature corresponding to the pressure of the steam inside the turbine. To know this fact is important, because the steam pressure during putting into service is a definite measure of the attainable and at the same time uniform warming-up temperature.

It is, of course, naturally advantageous to speed up the uniform warming-up of condensing turbines as much as possible, and it is therefore correct to effect this warming-up process with a poor vacuum. In addition to this, it is, however, particularly important that during warming-up the shaft shall be driven around by the steam right from the start, even if but slowly, in order that a uniform wetting shall take place of all parts in contact with the steam, so as to avoid temperature differences. For this warming-up process a speed of a few hundred revolutions per minute is sufficient. Its duration depends largely on the size of the turbine, on the thickness of the walls and on the general design characteristics.

When starting up back-pressure turbines, the valve in the back-pressure line should first be opened, unless an auxiliary supply of live steam at reduced pressure is available for warming up. If the back-pressure line is already under steam pressure, steam will, upon opening the valve, flow back into the turbine. Because in the case of primary turbines, due to the relatively high back-pressure, the saturation temperature is considerably higher than that existing inside condensing turbines, the warming-up temperature is correspondingly increased. This means that considerable temperature differences may occur, and special care must accordingly be taken to avoid warming-up too quickly. It is, therefore, advantageous in this case to open the back-pressure valve at first only slightly, so that the warming-up steam quantity remains small, and the rate of heat supply is kept low. By gradually increasing the opening of the back-pressure valve, the pressure inside the turbine can be slowly increased, and in this manner the warming-up process can be conducted until the full back-pressure is attained.

As already mentioned, it is essential for a uniform warming-up that the shaft shall rotate. Because in this case the warming-up is effected by steam from the back-pressure line, it is necessary to arrange for the shaft to be rotated either by hand or by means of a motor. If a hand-turning device is provided, it is sufficient to rotate the shaft periodically through 180 deg. The time required for warming-up is largely dependent upon the size and on the design of the turbine, and, last but not least, upon the operating temperature.

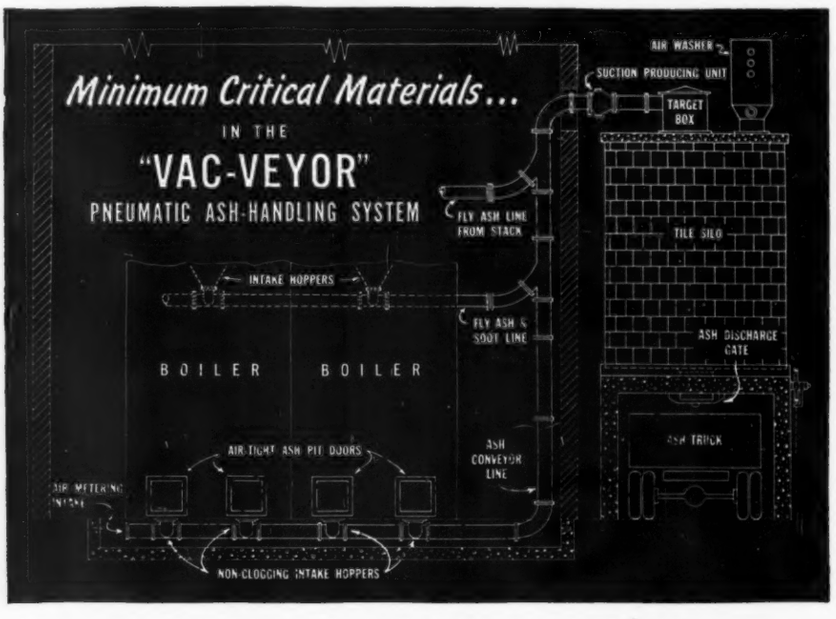
As soon as the turbine is under full back-pressure, the live steam stop valve can be opened as far as is required, in order that the steam admitted shall cause the shaft to rotate slowly. After this, the steam quantity and the speed are gradually increased, as in the case of the condensing turbines, until normal running speed is obtained.

Now and again, when it is possible to make use in some way or other of the reduced pressure exhaust steam, back-pressure and primary turbines may be warmed up by means of live steam. After being thoroughly warmed up—always with slowly rotating shaft—the back-pressure and hence the warming-up temperature may be raised by gradually closing the valve in the auxiliary exhaust line until the normal back-pressure is attained, whereupon the back-pressure valve may be opened. External heating of the flanges is of considerable value for back-pressure turbines and especially for primary turbines.

Restarting of Turbines after a Short Shutdown

Not only starting after a prolonged shutdown, that is, with the cold machine, but especially restarting after a limited shutdown interval, requires care and understanding. After a turbine is shut down, a continuous transfer of heat is effected by steam or air enclosed in the casing from the lower to the upper parts. Due to the increased rate of heat loss of the parts below the shaft axis and the consequent local cooling, a bending may take place of both the shaft and of the casing. It is evident that a bent shaft, upon restarting, will cause unsteady running and under certain circumstances may provoke severe vibration. If at the same time a certain amount of distortion of the casing has taken place, it may even be possible that rubbing may occur upon restarting.

There exists, however, a possibility of reducing these distortions to an admissible amount, if not entirely eliminating them. An increase in the thermal insulation of the lower casing half, compared with that of the upper casing half, leads to an appreciable improvement, because the resulting greatly reduced heat loss of the lower half largely compensates the effect of the upward heat flow inside the turbine. With extra high temperatures it is very advantageous to provide a heating arrangement at the lowest part of the casing, which during the shut-down compensates the heat loss due to convection inside the turbine. Electrical resistance heating in particular enables the heating load to be readily adjusted, so that the casing will not become bent. All these measures react favorably on the stationary rotor, because the temperature compensation achieved with the heating arrangement



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also improves the conditions for the shaft. The same effect may be obtained by artificial cooling of the upper part of the casing, as in this manner the heat rising to the top is more rapidly conducted away. Such a process would be useful in order to bring the turbine as rapidly as possible out of the half-warm state. It may, however, have undesirable effects, because considerable temperature differences between the walls of the casing and the thick flange parts may occur, tending to cause distortion.

In the case of large turbines turning gears have long been in use, by means of which, during a shut-down, the shaft is slowly rotated by hand or by a motor. This rotation is effected nowadays even with motor-drive with a speed of only about 1 rpm. This slow peripheral speed naturally makes proper lubrication difficult, and turning devices are accordingly often provided with an additional high-pressure oil pump, in order to lift the shaft from the bearing by means of an oil film. Finally, the device requires interlocking features, in order to prevent the turning gear from being engaged when the turbine is in operation or, conversely, to prevent the turbine from being started up as long as the turning device is engaged. The continuous rotation of the shaft during the shut-down is frequently replaced by periodic rotation through half a revolution, thus making high-pressure lubrication superfluous.

Shutting Down and Preparing a Turbine for Restarting

In considering the factors having an effect on restarting, it is first of all necessary to distinguish between the following three cases:

1. Shutting down for a long interval.
2. Shutting down for restarting at a given moment.
3. Shutting down for restarting at any instant.

Shutting down for a long interval requires no special measures. The distortion caused by the heat flow inside the turbine attains its maximum in a few hours, and then decreases as the turbine cools down, at first rapidly and then more and more slowly. This distortion depends, of course, both on the design of the turbine and the temperature, that is, on the load at the moment of shutting down. As is to be expected, the distortion occurring after a reduced temperature, and the restoration of the shaft shape also takes place in a shorter time. This effect of the load on the machine before shutting down is of particular importance for cases 2 and 3.

Shutting down for restarting at a given moment does not require any special precautions, because, since the moment of restarting is known, all the manipulations necessary for a smooth running-up may be effected shortly in advance of restarting. If the shut-down period is sufficiently long, for instance from the evening to the following morning, the straightening-out process, especially if the load has been reduced before stopping or if the machine has been allowed to run light for some time, may have gone so far as to make any special measures for restarting unnecessary.

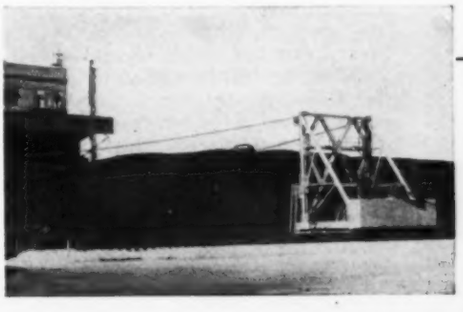
It should be remarked here that it is still possible to start up again with a small deformation of the shaft, because vibrations do not take place at the reduced speed maintained during warming up. Contact of the steam with the rotating shaft soon causes the latter to straighten out, and the machine can then be run up in the usual manner and paralleled. Even if slight vibrations occur, these disappear after a while upon temporarily reducing the speed, due to the shaft straightening out. Thereupon the speed can be increased again. It should always be borne in mind that the deformations of the shaft and of the casing must definitely lie within the clearance margin, in order that no rubbing shall take place during the first few revolutions, because an increase in the gland clearance would result in a reduction of the efficiency of the machine. If the shut-down is so short as to necessitate a reduction of the deformation still persisting, it is generally sufficient to give the shaft half a turn shortly before restarting, in order that it may become straight by the time it is due to go into service again. By giving the shaft half a turn, the hotter half is transferred to the bottom, and the heat flow immediately set up cools the hotter parts and warms the colder upper ones.

Restarting at any instant differs from the two foregoing cases in that the shaft has to be kept constantly straight within the allowable tolerance, in order that there shall never be any possibility of the rotor rubbing against the casing. Upon restarting, there occur then, at the most, slight vibrations until the shaft has straightened itself out, through slow rotation in contact with the steam. Continuous turning of the shaft by means of a motor drive has already been mentioned as a suitable solution for maintaining the shaft straight.

The natural deformation of the shaft can also be kept within the admissible tolerances by means of periodical rotation through half a revolution, thus again avoiding any possibility of rubbing of the shaft on the casing.

After such a half-revolution the shaft is distorted downwards by the same amount that it was previously distorted upwards, and the heat flow causes the deformation to retrogress until it crosses the axis and begins to build upwards. After a certain time the limit is again reached, so that the shaft has to be rotated once more. Because of the general cooling effect the rate of deformation becomes more and more slow, so that the half turns take place at increasingly long time intervals. Finally, the maximum deformation remains within the tolerance and no further rotation of the shaft is necessary.

Naturally, it is advantageous for this case of constant readiness, to reduce the load, if possible, down to light running before shutting down, in order to effect a preliminary cooling.



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•For larger storage areas there are Sauerman Systems with self-propelled movable tail towers. The 7 cu. yd. Scraper System, illustrated above, now in operation for 13 years, handles an average of about one million tons of coal per year (both storing and reclaiming) for this 160,000 kw. generating station.

Sauerman Advantages:

Low-cost equipment
One-man operation
Higher stockpiles
Greater safety
Upkeep simple
Adjustable to any space

AT hundreds of power plants, SAUERMAN Power Drag Scrapers are storing and reclaiming coal at costs of only a few cents per ton handled.

A Sauerman System is simple and easy to operate. From a station overlooking the storage area the operator controls every move of the scraper through a set of automatic controls.

A Sauerman Scraper stocks the coal in compact layers. There is no segregation of lumps and fines—no air pockets to promote spontaneous combustion.

Each Sauerman installation is a permanent, trouble-free investment—maintained at small expense.

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Government Forewarns on Fuel Deliveries

This survey of the fuel situation, compiled from various government sources explains why it is imperative that consumers stock as much coal as possible during the summer months; it forecasts the increased demand during the next heating season, and shows why relaxation of present oil restrictions cannot be expected. This means that wide-scale conversions will continue to be necessary and should be initiated while there is still opportunity to secure deliveries of equipment and coal for storage.

WITH the mining of coal now apparently assured without interruption until the end of October, after three suspensions in production this year, it is especially important that consumers take full advantage of all opportunities to store coal, to guard against the consequences of possible further complications at the expiration of the present arrangements, and to compensate for the withdrawals from stockpiles during the recent interruptions in delivery.

Apropos of the situation is a survey gathered from several governmental sources and recently released through the Office of War Information. From this the following excerpts are taken:

The Nation's 1943 soft coal requirements are the largest in history, totaling approximately 600 million tons, or an increase of 20 million tons above those of 1942. Anthracite will top the 1942 needs by 5 million tons. Of the bituminous coal output, 130 million tons will be required for the heating of office buildings, public buildings, schools, hospitals and homes. This increase of 10 million tons over last year can be traced to conversions from oil to coal.

Due to strikes, coal production for the first half of 1943 was 1,729,000 tons less than that for the same period of 1942.

Balanced against this need for increased coal production are the shortage of manpower at the mines and a shortage of equipment and supplies. The coal industry has lost approximately 60,000 miners to the armed forces and to war industries, although replacements have tended to hold the net number about in balance. However, the recruiting of miners is difficult as the modern mine is highly mechanized and needs trained men. Also, some states require certificates of experience gained through apprenticeship because of the hazards involved.

Recent adoption of the six-day week has partly compensated for losses in men.

The Solid Fuels Administration and the War Production Board are working out plans to meet the shortages in new and replacement equipment, and the latter has already established the procedure by means of which mines may obtain maintenance equipment. However, it is worth pointing out that mining machinery uses materials also needed by war plants while, on the other hand, these war plants need the coal.

Transportation a Vital Factor

Another factor affecting the adequacy of the coal supply is transportation. Coal must generally be moved as rapidly as it is mined and the coal movement pattern is a complex one. The war is imposing a tremendous burden on the railroads which carry most of the coal and in which coal comprises the largest load. In fact, one in every three freight cars is a coal car. Moreover, it is estimated that next winter will require from 225 to 240 million more miles of such car service than were required last winter.

This is because the coal-hauling railroads have lost much of the help they formerly received from coastwise colliers, as well as much of the assistance they received from motor trucks. There is a limit to the amount of coal that can be transported on lakes and rivers and the late opening of transportation on the Great Lakes last spring placed an additional burden on the railroads. Finally, the Office of Defense Transportation calls attention to the fact that the limited supply of coal cars sometimes makes it difficult to assemble sufficient cars for six-day operations at the mines, and few additional cars will become available this year—probably not in excess of those that will have to be retired.

To increase the efficiency of railroad transportation, cars are being loaded to maximum capacity; turn-around time has been cut; and new routes have been developed to bypass bottlenecks.

Despite these measures, the customary peace-time loads in fall and winter, and low loads in spring and summer cannot be continued. If coal movements slacken in the non-heating season, the railroads will not be able to haul enough extra coal in the heating season to make up the difference. The desired week-by-week mining and movement of coal, to replace the seasonal curve, depends upon consumer understanding of the problem and cooperation in meeting this problem.

To this end Solid Fuels Administrator Ickes urges that coal be ordered and users take deliveries as it can be supplied. That is, industry must help maintain production by ordering coal now and providing adequate storage facilities. While he promises to do everything within his power to prevent a coal emergency from curtailing war activities, he reiterates that the best insurance against such an occurrence is the consumers' stockpiles. In this connection, he advises allowing the dealer the fullest possible latitude as to size and kind of coal, shipping and delivery schedules and type of transportation equipment to be employed. For essential war industries, storage of from 90 to 120 days' supply, and for other industrial users, 60 to 90 days' supply is urged.

A survey by the Bituminous Coal Division showed that stockpiles were increased by only 838,000 tons during May whereas they should have increased by more than three million tons, and that further ground was being lost in June because of the subsequent interruptions in supply. It will be difficult and perhaps impossible to regain this lost ground. While coal in the hands of utilities was apparently adequate, some 1700 plants, including a large number of those engaged in war production, had less than ten days supply on hand.

Oil Supply by Tank Cars

The present petroleum shortage exists in terms of low storage stocks. In the East these are already at dangerously low working levels, and even in the West they are lower than they were before the war. The concern of the Government is to improve the situation so as to prevent future critical shortages and to provide a cushion in anticipation of emergencies.

In peace-time, about 95 per cent of the total oil supply reached the Eastern Seaboard by tanker from the southwestern oil fields, around the Gulf and up the coast, as well as from Venezuela. An average tanker docked at some Atlantic seaport once in about every 50 minutes. With coastwise service disrupted by diversion of tankers to war service and by the submarine menace, oil transportation by railroads, pipelines and waterways had to be substituted. This placed a tremendous burden on the railroads.

Up to the time of the diversion of the tankers, hardly a tank car was used in transporting oil to the East, because this was expensive—in general, about five times that by tanker. However, in one year, the movement by tank car from the oil fields of the Southwest to the oil-consuming centers of the Northeast rose from virtually nothing to about 830,000 bbl a day. At present, 70,000 tank cars are engaged in bringing about 900,000 bbl to the East Coast daily, and by fall it is expected that this figure will be increased to a million barrels.

These 70,000 tank cars, with an average capacity of 9300 gallons each, are 64 per cent of the total tank cars in petroleum service in all parts of the country, and the regions in the Midwest and Southwest from which they have been diverted have suffered accordingly. Since this number of cars is considered the optimum that can function fully in this task, in view of the capacity of loading and unloading facilities, the railroad situation, and the de-

mand elsewhere, no more cars are now being considered for diversion. They operate on a seven-day schedule, with no idle weekends, cross-hauls and back-hauls are eliminated as far as possible, and 90 to 95 per cent of the oil tank car movements are now in solid trains operated on fast through routes scheduled by the ODT. The diversion of short-haul traffic, within a radius of 200 miles from the point of origin, to motor trucks, has already released more than 14,000 cars for long hauls.

Contribution by Pipe Lines

The "Big Inch" a 24-in. pipe line from the oil fields of Longview, Texas, to Norris City, Ill., is the biggest oil pipe line in the world and by this August it will be extended to the Atlantic Seaboard. This line can bring 300,000 bbl of oil daily to Norris City for transhipment by rail. When the final section is completed in August this quantity of oil will be brought directly to the New York-Philadelphia area.

Approximately 50 per cent of the crude oil carried by the "Big Inch" is now reaching refineries in the Philadelphia area, 41 per cent will go to those in the New York-New Jersey area and 9 per cent to New England.

A 20-in. pipe line running approximately parallel to the "Big Inch" has been authorized and is expected to be completed by the first of the year, provided materials are delivered on schedule. It will carry gasoline, kerosene or other refined petroleum products which move faster and require less pumping machinery than the crudes. These products will average an estimated 235,000 bbl daily and will be made available, first, for military, lend-lease and other war purposes and any remainder will be available for essential industrial, commercial and civilian use.

Despite these measures, Mr. Ickes believes that the Government will not be able to relax present fuel oil or gasoline rationing restrictions.

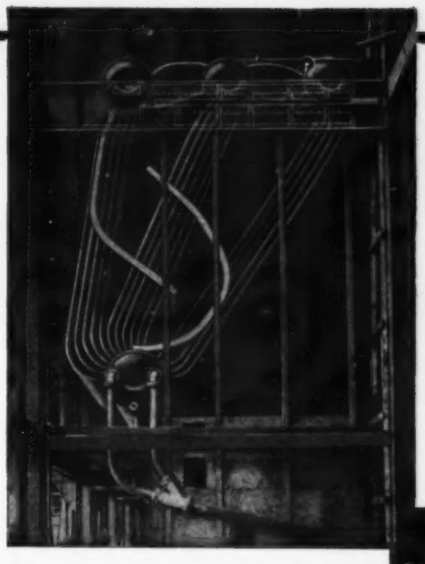
Largest 3600-Rpm Turbine-Generator Placed in Service

A 65,000-kw, 3600-rpm turbine-generator, said to be the largest of its type, has lately been placed in service at the new Harbor Plant of the Bureau of Power and Light, Los Angeles, Calif. This machine, built by Westinghouse in approximately two years and two months at a cost of over a million dollars, is of the tandem-compound type and operates at 850 psi throttle pressure and 900 F. In its design and construction special attention was given to precautions against misalignment due to earthquake shocks and it is provided with devices for detecting and recording vibration, expansion and eccentricity, any excess of which might lead to possible trouble in the 43-ton rotor. Small temperature detectors are also embedded in the armature winding to record any tendencies toward overheating. The generator is hydrogen-cooled, with 400,000 lb per hr of hydrogen passing through the coolers.

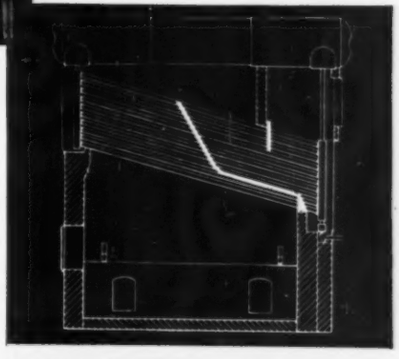
Steam is supplied to the turbine by a single boiler rated at 675,000 lb per hr and designed to burn either gas or oil.

MORE STEAM

QUICKLY EASILY



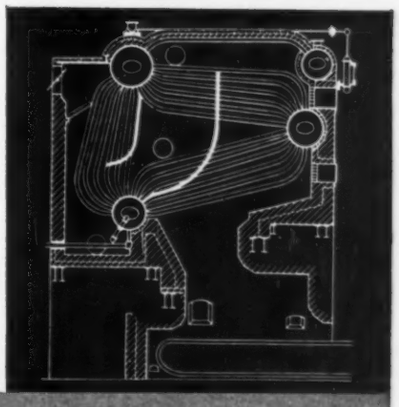
Steam output can be boosted quickly and easily by installing Enco baffles. These streamlined baffles prevent eddy currents and dead gas pockets. The cross-flow puts every square foot of heating surface to work.



Enco baffles reduce draft loss by doing away with bottlenecks in the passes. They save steam because soot blowers are more effective and used less often.

Each application is individually designed on the basis of 25 years experience with Enco baffling in all types of water-tube boilers.

Installations are made by skilled mechanics with selected materials.



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Chinese Institute of Engineers Meets in New York

The American Section of the Chinese Institute of Engineers, which originated in this country in 1919, held its convention at the International House, New York City, on June 26 and 27, 1943. Since July 1937 the activities of the American Section have declined, and this was the first annual convention since its revival last August. During that time its membership has risen from scarcely over 100 to more than 350.

The two-day program included general business sessions, technical sessions, social meetings and a banquet. The technical sessions consisted of lectures and papers presented to different groups including: Aeronautical, Mechanical, Electrical, Civil, Chemical and Metallurgical Engineering.

Among the speakers were Dixon R. Speas, of American Airlines, on "Airline Engineering," Dr. Chung-Yu Wang, Technical expert to the Ministry of Economic Affairs of the Chinese Government, on "Post-War Development of Chinese Mineral Industries," Dr. T. P. Hou, Chief Engineer of Yung Li Chemical Works, on "Low-Temperature Carbonization," and I. E. Mouromtseff, of the Electronic Engineering Dept. of Westinghouse Elec. & Mfg. Co. on "High Frequency Generators and Their Applications."

At the banquet held at the Hotel New Yorker, the Chairman, L. F. Chen, President of the American Section of C. I. E. and representative of the National Resources Commission of China, gave a very impressive address, in which he stressed the responsibilities of Chinese Engineers for the reconstruction of China. He demonstrated the need for power plants in China by an interesting comparison of the electrical energy consumed per capita in different countries, namely: United States—about 1000 kw; England—about 700 kw; Germany, France and Japan—about 500 kw; and China—about 3 kw.

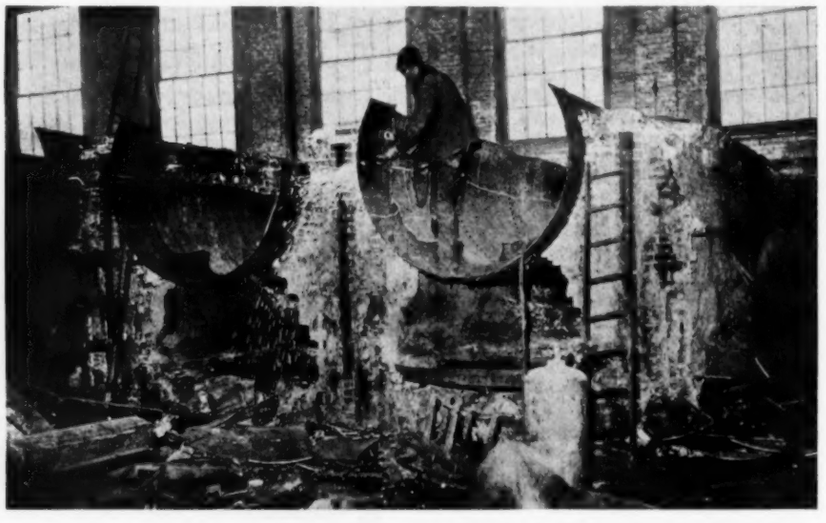
Other effective speakers were Dr. S. A. Trone, Dr. Ching-Chao Wu and E. B. Whitman who dealt with different phases of post-war reconstruction. In a country where the idea of industrialization is not yet firmly rooted, where national resources have been sapped and industries have to be developed, the responsibilities of Chinese engineers are manifold, and only concerted effort could accomplish the tremendous tasks involved in the building of a new industrialized China. To that end the future development of the C. I. E. was dedicated, and the large and enthusiastic gathering that marked the convention should be regarded as indicative of the dawn of a new and happier day for China.

Energy Output Continues to Rise

The Federal Power Commission announced on July 5 that the electric energy output of the principal public utility systems of the country during May of this year totaled 17,451,448,000 kwhr which represented a gain of 19.6 per cent over the same month last year. Corresponding peak demands were up 16.7 per cent. The respective increases for April were 18.9 per cent and 15.6 per cent.

The Commission states that estimates of 1943 output, as made by the Class I electric utilities, total 215,378,574,000 kwhr for the year with a peak of 37,806,452 kw estimated for next December. The latter figure represents a decrease of some 52,000 kw from that forecast in April. The greatest percentage increase in both output and demand occurs in the Southeast.

New generating capacity placed in service during May amounted to 226,000 kw, according to nameplate ratings. Scheduled additions by the end of 1943 amount to 2,396,800 kw.



Three of seven boilers in the old George Gilbert Woolen mills in Gilbertville, Mass., which yielded 450 tons of scrap this Spring

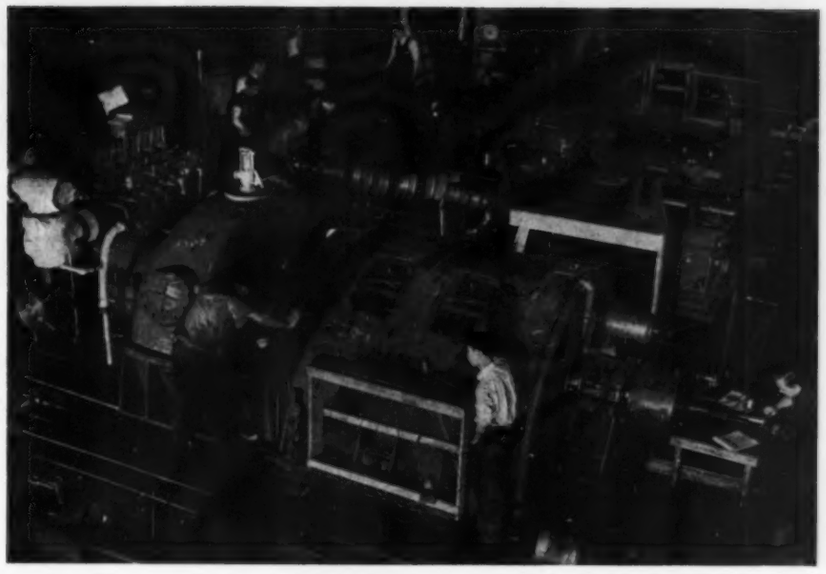
War Standard Revised Ratings of Pipe Flanges and Fittings

At the request of the WPB, the American Standards Association has completed a War Standard revising ratings of pipes and flanges. Because of the wide application of this standard, we print the following from a review by N. O. Smith-Petersen[1] which appeared in the June issue of the ASA house organ *Industrial Standardization*.

In 1928 the American Engineering Standards Committee (now the ASA) issued a standard for cast-iron flanges and fittings giving a pressure rating of 125 psi (gage) for all pipe sizes. The material to be used was specified in three grades: 20,000 psi cast-iron for pipe sizes up to and including 3½ in.; 21,000 psi material from 4 in. to 42 in., inclusive; and 24,000 psi material above 42 in.

In 1939 a revision of this standard was approved which embodied a betterment in material for sizes 1 in. to 3 in., inclusive, and above 12 in., together with a reduction in steam pressure ratings for sizes above 5 in. This revision was not responded to by the industry because the reduction in pressure ratings did not correspond closely enough to established usage. When the steel shortage made necessary the use of cast iron to its full extent, this situation became in urgent need of adjustment.

[1] Chairman ASA War Committee on Rating of Pipe Flanges and Fittings.



Test on G. E. turbine-generators for tankers and troopships

The War Production Board therefore requested the War Committee on Rating of Pipe Flanges and Fittings to revise pressure ratings for the standard. Because of the lack of authentic formulas for ascertaining the loading effect upon flanges with elastic gaskets out to the bolt holes, the War Committee could only be guided in its pressure revision by past practice authorized by the 1928 standard which permitted a pressure rating of 125 psi (gage) for sizes 4 in. to 42 in., inclusive, for 21,000 psi cast iron. As this range in size for this pressure rating is not in accordance with present-day practice, the range was reduced and the pressure rating of 125 psi (gage) permitted up to and including 12 in. for 21,000 psi cast iron, and 100 psi (gage) for 14 in. to 24 in. for 31,000 psi material.

Why specify S. E. Co. *Complete* "Bunker-to-Stoker" and "Bunker-to-Pulverizer" Installations?

S.E.Co. complete "Bunker-to-Stoker" and "Bunker-to-Pulverizer" installations are marked by a thorough consideration of every detail of design . . . dust-proof . . . freedom from coal sticking . . . no coal segregation . . . heavy construction . . . proper supports . . . Cast Iron Bunker Outlet Collars . . . Scale Floor Inserts . . . excellent appearance . . . tight joints . . . complete equipment. For informative catalogs and bulletins write to Stock Engineering Company, 9803 Theodore Avenue, Cleveland, Ohio.

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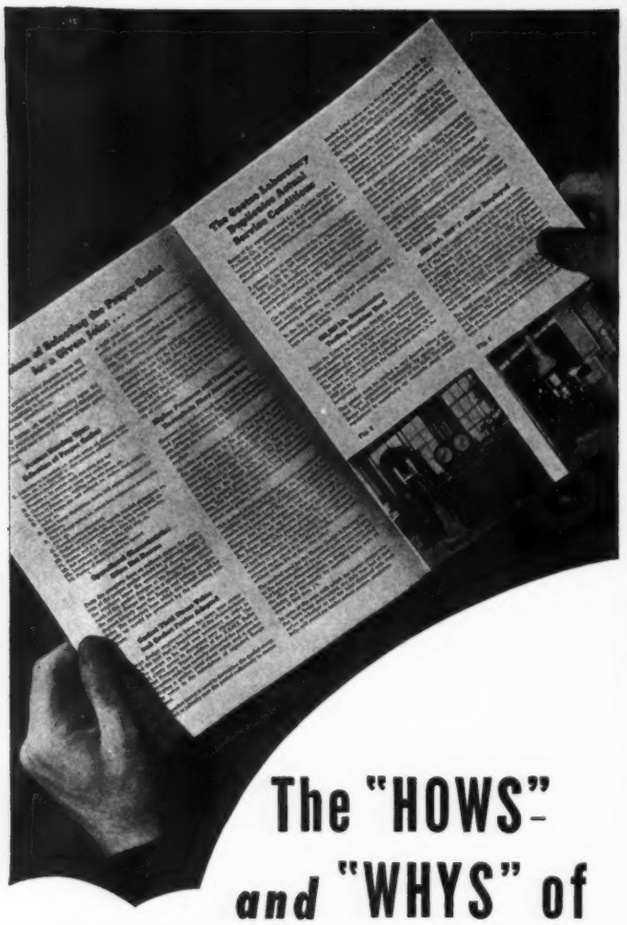

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Valuable in any location, whether in open or in hard-to-see positions, the PRISMATIC window shows water in *black* and steam in *white*—easily read from a distance. Further important safety lies in the heat treated shatter-proof glass, which is securely clamped in strong insert body.

Reliance PRISMATICS are designed for various pressures and furnished in several single lengths, or assembled (at factory) in multiples to fill any visibility need.

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Boiler Safety Devices since 1884

George E. Learnard

George E. Learnard, former president of International Combustion Engineering Corporation, died at his home in Larchmont, N. Y., on July 11 at the age of sixty-nine. Born in the suburbs of Boston, July 16, 1874, Mr. Learnard's early business career was in the field of finance, and he subsequently became an officer of the Grieve Grate Company. He was instrumental in bringing about the amalgamation of that company with the American Stoker Company in 1914, under the name of Combustion Engineering Corporation, and the Coxe Traveling Grate Company was added the following year. With broad vision as to the rôle of combustion in industrial progress he organized International Combustion Engineering Corporation in 1920 which included affiliates in six different countries and soon expanded to include boilers, pulverized coal, heat-recovery equipment and coal processing. He served as president of the company until late in 1929.

Interment was private in Cambridge, Mass. Immediate survivors are his wife, Elinor Nye Learnard, and a sister, Mrs. Arthur Badger.

WPB's Construction Advisory Service

Following the general curtailment in facilities construction, prospective applicants who wish to know what considerations now govern the granting of authority to begin construction should consult the Construction Advisory Service of the new WPB Facilities Bureau in Washington. This service will advise manufacturers and builders, on the basis of preliminary drawings and approximate listings of building materials, before they submit formal applications to begin construction. Architects, engineers and other employees of firms contemplating new industrial facilities construction (except Army, Navy or Maritime Commission projects) should write to Howard W. Cutler, Chief, Construction Advisory Service, Project Division, Facilities Bureau, WPB, Washington, D. C.

Surplus Steel Valves Needed

The War Production Board has moved to relieve a critical shortage of new steel valves needed for the war program, by calling upon users of new high-pressure steel valves to list their surpluses with the WPB Redistribution Division. When so listing, the owners are to indicate whether they are willing to sell the valves to the Government and whether the valves must later be replaced. Surplus valves are defined as those which the present holders will not require for use before Nov. 1, 1943.

Valves owned by one Government agency which are needed by another Government agency will be transferred directly under arrangements mutually satisfactory to the agencies concerned.

Surplus valves that are to be moved into or out of the hands of private owners will be purchased by the Metals Reserve Company through its agency, Murray Cook, at market prices, and resold to steel valve manufacturers to assist them in meeting current war orders. The transportation costs involved will be borne by the Metals Reserve Company.

WPB Rules on Power Boilers

Order No. L-299, issued by the War Production Board on July 1, provides that power boilers, except those for locomotive or marine service, may not have a greater metal thickness or quantity of steel than needed to meet the minimum thickness requirements of the A. S. M. E. Boiler Construction Code. Boilers affected are those for a design pressure exceeding 15 lb per sq in.

These restrictions do not apply to boilers in process on July 1, or those into which a tube is rolled.

Personals

T. W. Howard has been appointed Superintendent of the turbine and marine installations section of the General Electric Company's Service Engineering Division, succeeding **J. C. Mahoney** who has retired after 21 yr in that position and 40 yr with the Company. Mr. Howard had been assistant to Mr. Mahoney since 1920.

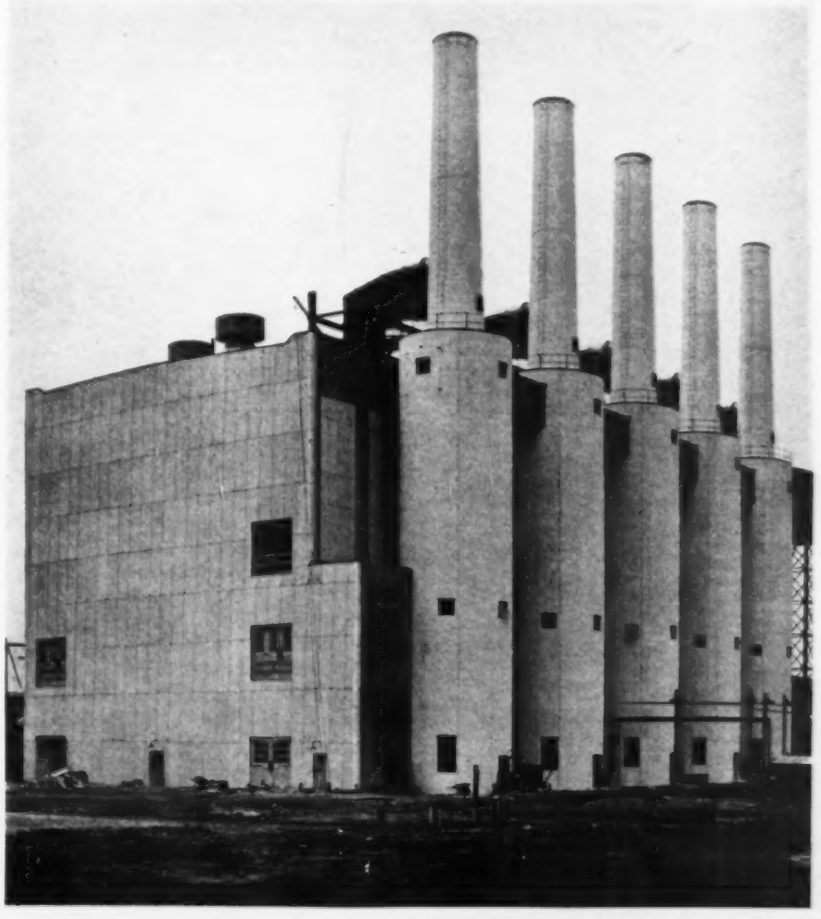
W. A. Yost, Jr., has been named Manager of the Marine Division of the Allis-Chalmers Mfg. Company's Steam Turbine Department. Previous to this he had been with Elliott Company for the past 16 yr.

Edmund McCarthy has joined the technical staff of the Coal Bureau of the Upper Monongahela Valley Association with headquarters at Fairmont, W. Va. He comes to the Bureau from the Philadelphia & Reading Coal and Iron Company, where he served as fuel engineer, and prior to that connection had been a boiler-room test engineer with the Consolidated Edison Company of New York.

Nevin E. Funk, Vice-President in Charge of Engineering of the Philadelphia Electric Company, has been elected President of the American Institute of Electrical Engineers for the year beginning Aug. 1, 1943.

David MacGregor has been appointed Chief Engineer of The Edward Valve & Mfg. Company, East Chicago, Ind. He has been associated with that company in various engineering capacities since 1925.

Edgar C. Brandt has been elected Vice-President of the Elliott Company, in charge of manufacturing. He comes to that company after 38 years of experience with the Westinghouse Electric & Mfg. Company.



Released for publication by the Corps of Engineers

This unusual arrangement of coal silos and stacks is at an Ordnance Plant in the Northwest which contains five 190,000-lb per hr boilers

NEW CATALOGS AND BULLETINS

Any of these publications will be sent on request

A-C Welder

Allis-Chalmers Mfg. Company, in a 4-page leaflet, announces its new Ampac "200" alternating current welder. Important features of three leading types of transformer welders are compared with the Ampac "200." Electrical specifications and a dimension diagram are also given.

Flexible Metallic Tubing

Titeflex Metal Hose Company has issued a new 36-page catalog (No. 113) which deals with the general industrial applications of its line of flexible metallic tubing for the conveyance of oils, gases and liquids. Complete information is given on available fittings. Also included are pressure charts, charts showing radius of bend, and other essential data. Many applications for flexible metal tubing are pictured and described, together with instructions for installation of the tubing.

Loss of Head Through Small Valves

The University of Illinois Engineering Experiment Station has published in its Bulletin Series No. 340 an interesting study by Wallace M. Lansford on "Loss of Head in Flow of Fluids Through Various Types of $1^1/_2$-In. Valves." This 36-page bulletin is illustrated and provides a study of the hydraulic characteristics of small valves by means of dimensionless parameters so that the laws obtained permit the extension of test results to the flow of any fluid through all valves that are geometrically similar to those tested. The tests reported were made on twenty-nine $1^1/_2$-in. brass valves, including gate, globe, check and Y valves, all of the threaded or screw-fitting type. The price of the bulletin is 40 cents per copy.

Motor Controls

A generously illustrated 16-page General Electric manual (GEA-4015) entitled "Simplified Guide to the Selection and Application of Commonly Used Motor Controls" has just been issued. Starting with a simple analysis of the functions of control, the booklet next describes the basic control parts of industrial devices and discusses the selection of correct control, either manual or magnetic, and when reduced-voltage starting is necessary. A breakdown is given of standard controls available, describing their operation and function, and a description of enclosures for industrial control devices.

Manganese Steel

The American Manganese Steel Division of the American Brake Shoe Company has just published a 48-page bulletin (No. 543-G) entitled "Manganese Steel for General Industry." This bulletin is lavishly illustrated with photographic halftones showing numerous applications of this tough and ductile metal in such industries as heavy chemicals, glass, sugar, paper, gas and coke, steam power plants, founderies and others where its use is not so general as in the mining and steel industries and railroads.

Prismatic Gage Glasses

Bulletin 434 just published by The Reliance Gauge Column Company illustrates and provides complete data on the Reliance Prismatic "Safety Water Gage" for both vertical and inclined installation. Prismatic inserts are available in single, double, triple and quadruple prismatics and can be mounted in multiple assembly for any gage need.

Proportioning Equipment

D. W. Haering has issued a new 8-page bulletin describing its latest proportioning and sampling equipment. The Haering Fluid Piston principle as applied to continuous sampling and proportioning equipment is discussed and also the operation and application of the improved Nelson chemical proportioning pump. The bulletin is illustrated with installation views and diagrams.

Smoke Regulation

The Department of Smoke Regulation of Hudson County, N. J., has issued a 24-page booklet of Rules and Regulations governing details of fuel burning equipment required for issuance of permits and certificates. Anyone interested may secure a copy by sending a 3-cent stamp to the Department of Smoke Regulation, Court House, Jersey City, N. J.

Pumps

The De Laval Steam Turbine Company is distributing an 8-page illustrated bulletin (E-1179) entitled "Cleveland Pioneered," which recounts briefly the planning and development of Cleveland's three pumping stations, all equipped with geared turbine-driven centrifugal pumps. The bulletin includes a chart which shows the duties to be expected from pumping units of various capacities.

Spot and Seam Welding Data

The American Welding Society has published a 4-page leaflet "Recommended Practices for the Spot and Seam Welding of Low Carbon Steel." The data contained in this bulletin is intended to meet the needs of the U. S. Navy and War Departments and those in industry engaged in the production of war material. Two charts are given—one each for spot and seam welding, together with an explanation for their use. Copies may be obtained from the American Welding Society, price 10 cents.

Steam Traps

Strong, Carlisle & Hammond Company has issued a new 24-page catalog (No. 66) describing its steam traps and drainage equipment. Open bucket and inverted bucket type traps are admirably illustrated by halftone sectional views and for each series a capacity, dimension, weight and list price table is given. Special features are fully described and two pages are devoted to technical information on size selection for specific purposes.

Storage Tank Oil Heater

A new 12-page bulletin (No. 1641) on the G-Fin storage tank oil heater has been prepared by the Griscom-Russell Company. The bulletin is liberally illustrated with halftones and diagrams which show the unique construction of the G-Fin elements and the different arrangements in which the heater is furnished. Complete tables of dimensions and ratings are also given. 285 Madison Ave., New York.

Wartime Conservation

"Wartime Conservation," a new 96-page booklet (B-3206) just published by Westinghouse Electric and Manufacturing Company, contains recommendations by Westinghouse engineers for selecting, applying and using electrical equipment to achieve the best possible output with the greatest saving in critical materials. The book covers up-rating of motors, thermal temperature loading of transformers, industrial network systems, line equipment and materials; and gives tips on saving and salvaging materials as practiced in the Westinghouse plants.

Water Conditioning

"Boiler Feed Water Conditioning and Chemistry" is a new publication (4008) issued by the Cochrane Corporation which deals with the most common processes used in feed water conditioning, and discusses the characteristics of the hot process water softener, zeolite softener, removal of gases from boiler feed water, embrittlement and carryover. In addition there is a section devoted to interpretation of water analyses, conversion factors, chemical reactions, tables showing formulas, molecular weights, equivalent weights of all chemicals commonly found in water conditioning practice.